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EFFECT OF NEW-GENERATION PLASTICIZERS ON THE PROPERTIES OF CLAY PASTES

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Litoplast M plasticizing additives yield a plastic clayey paste with optimal molding properties. These modifiers increase the mechanical strength and decrease the open porosity and water absorption of the finished product.

Key words: plasticity, Litoplast M, molding moisture, mechanical strength, building brick.

In the manufacture of building brick, paste properties such as the plasticity, cohesion and density play a decisive role in securing product quality. These properties are determined by the quality of the clay raw material used but within certain limits they can be regulated by means of special additives. Plasticizing additives are used to improve the rheological properties of clay pastes; these additives facilitate the extrusion process, increase the velocity and density of the block, and lower the water content, which increases the product quality and economic efficiency of the manufacturing process.

It is quite difficult to fit plasticizers to pastes consisting of several clays and a nonplastic material. Since the plastic properties of clays depend mostly on their mineral content and dispersity, a specific plasticizer — liquefier — must be used for particular clays.

Series Litoplast M new-generation plasticizers produced by Poliplast Novomoskovsk JSC make it possible to lower the moisture content and increase the density of the slip, while preserving its rheological properties.

Plasticizers are complexes of directly synthesized surfactants in which the structure of the polymers changes owing to chemical modification of polymethyl naphthalene sulfonates (PNS) [1].

Plasticizer molecules contain one or several polar groups and dissociate in a water solution with formation of long-chain anions, which determine their surface activity. With the adsorption of surfactant molecules beyond the first layer a second layer where hydrophobic radicals interact with one another while polar groups are oriented toward the water can form. Such a structure of a diffusion shell makes it possible for the clay particles to slide easily relative to one another, as a result of which the viscosity decreases.

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The present work studies the effect of series Litoplast M additives on the properties of clayey raw material for the production of building brick and mix, consisting of clays from the Krasnoarmeiskoe and Starkovskoe deposits and sols — fly ash from State Regional Electric Power Plants.

The plasticity of clays was determined by Vasiliev's method. The upper limit of the moisture content was determined using a balancer cone and the lower limit by rolling into cord.

For example, for the Krasnoarmeiskoe deposit the additives Litoplast 1M, -3M, and -5M added in the amount 0.3%[3] showed the greatest liquefaction effect. In this case Litoplast 3M is more effective, lowering the moisture content of the paste by 4.0% while preserving the plasticity (Table 1).

Additives decrease the amount of water and increase the packing density of the particles in the molding paste. This improves sintering, increases mechanical strength and decreases water absorption by the finished articles.

The samples — cubes with 50 mm edge length — were prepared for the laboratory studies by plastic molding in metal molds. To determine the effect of the additives on the physical-chemical properties of the samples tests were performed on compositions without additives (standard mix) and with series Litoplast M additives in amounts 0.3%. The

[3] Here and below the content by weight, %.

TABLE 1. Effect of Litoplast M additives on the Molding Moisture Content of Clay from the Krasnoarmeiskoe Deposit

Additive type	Additive content, wt.%	Moisture content of clay at the fluidity boundary W_{rel}, %	Plasticity number
No additives	–	20.5	
Litoplast 1M	0.3	17.5	14.0
Litoplast 3M	0.3	16.5	
Litoplast 5M	0.3	17.8	

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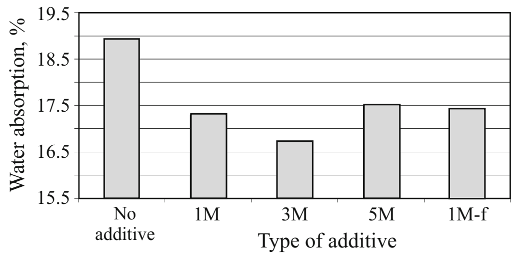

Fig. 1. Water absorption of kilned samples versus the type of Litoplast additive.

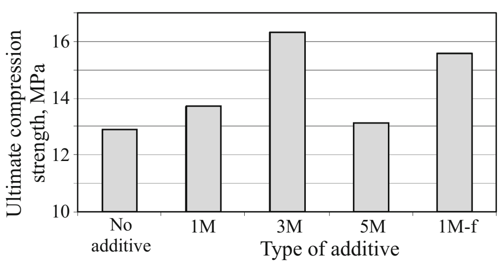

Fig. 2. Mechanical strength of kilned samples versus the type of Litoplast M additive.

samples were first dried in air for 24 h, and then in a laboratory desiccator at 110°C. The dried samples were kilned in industrial tunnel furnaces at maximum temperature 1070 – 1080°C. The data obtained are shown in Figs. 1 and 2.

It is evident from the data presented that the introduction of 0.3% Litoplast 3M increased the mechanical strength of the samples as compared with that of the standard by 26% — from 12.9 to 16.3 MPa — and decreased water absorption by 2.2%. The action of Litoplast 1M was intensified by introducing phosphates, as a result of which the strength increased by 21% (to 15.6 MPa) and water absorption decreased by 1.5%.

Microstructural analysis (Fig. 3) showed that the standard (no additive) sample (Fig. 3*a*) has total porosity 25 – 30% (the matrix has a loose structure). The amount of glass phase was estimated to be 30 – 40%.

The sample with Litoplast 3M additive (Fig. 3*b*) is characterized by an even surface, uniform color, uniform structure with no defects over the entire section, porosity 12 – 15%, and glass phase amount 15 – 20%.

Owing to the low plasticity of the clay raw material and the large amount of process moisture in the paste the standard samples have a more porous structure, which was set during the formation of the block. During kilning the fill particles became sintered together because of a glass phase that formed but the elevated porosity between the clay particles and the fill impeded the formation of a stronger sinter, which was reflected in the mechanical strength of the samples. Pores, which arose during the formation of the article, and voids, which formed as a result of chipping of the weakly bound grains at the time the sample was polished, can be seen on the surface of the sample.

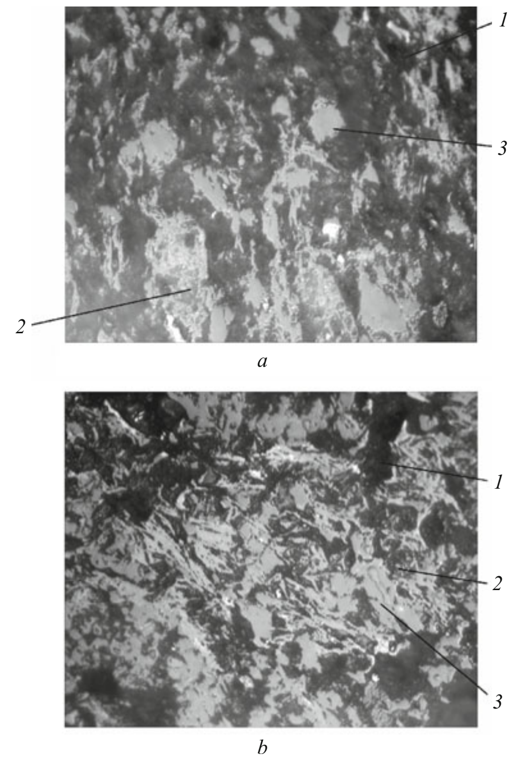

Fig. 3. Microstructure of sample wall, ×40: *a*) standard; *b*) with Litoplast 3M additive; *1*) pores; *2*) glass phase; *3*) mineral part.

Samples obtained using Litoplast 3M additive have a denser microstructure, appreciably fewer pores and a uniform pore distribution over the volume of the sample. The glass phase, formed during kilning, possesses a complex mineral composition. On account of the dense structure obtained during the formation of the block more complete interaction between the clay particles and the mineral fill occurred during kilning, which increased the mechanical strength of the article and decreased the number of cracks.

CONCLUSIONS

The introduction of Litoplast series additives separately or in a complex with inorganic additives makes the following possible:

– obtaining a plastic clay paste which possesses good formation properties;

– improving the exterior appearance of the articles, decreasing or completely eliminating rejects due to cracks;

– regulating the rheological properties and moisture content, decreasing the drying time and energy consumption on removing moisture from articles;

– increasing the mechanical strength and lowering water absorption of the finished product.

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